OXC - 1774
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5 June 1961

MEMORANDUM FOR : Chief, Development Branch, DPD-DD/P

SUBJECT : Aerodynamic Status Report No. 2 (Performance) SP-237, dated 1 January 1961

1. This report summarizes the basic performance data of the A-12 airplane as of 1 January 1961. The report updates the information presented in SP-152. It will be the source of basic data for the final performance analysis with the powerplant data from the final specification. However, no significant changes are expected in the re-evaluation.

2. My general impression of the report is that it is a very poor presentation. The data presented is consistent only in its inconsistency. Obsolete data are included along with revised data with no indication that it is obsolete. The new data does not maintain the integrity of continuance from one page to the next. Generally, insufficient data are presented to progress from one chart to the next. Some data of intense interest pertinent to operational considerations are not included. The over-all conclusion to be drawn is that the report is either: (1) poorly prepared, or (2) very carefully prepared with an intent to confuse. In some cases, detailed information is given on the methods of obtaining and reducing the data. However, no descriptive conclusions are drawn from the results (except tabular range information). There are some questionable assumptions used in the methods of data reduction.

3. Some of the errors, inconsistencies, and areas of concern are as follows:

A. The new report lists significant aircraft dimensions of wing area 1605 sq. ft., MAC 37.78 ft. and span 56.67 ft. The detailed drawing on the following page gives 1795 sq. ft., 40.555 ft., and 59.0 ft. for the same dimensions. The 190 sq. ft. of wing area reduction is 10.6% of the previous size and represents 11.83% of the present figure. No explanation is given for the wing redesign. My speculation (without any material justification at this time) is that the decrease in size is to provide greater rigidity to counteract a heretofore unmentioned aeroelastic problem. There are, of

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course, many reasons for wing redesign. Without an explanation in the report, the tendency is to presume a detrimental conclusion whether or not such reasoning is warranted.

B. The design zero fuel weight and takeoff gross weight are now given as 48,400 pounds and 117,000 pounds. Previous figures were 2,000 pounds below these weights. Eighteen months ago, the maximum weight was 113,000 pounds. Former reports listed 115,000 pounds as an overload condition and placed many restrictions on taxi operations, turning radius, and towing procedures at this extreme weight. Now the increase has gone into basic airframe rather than fuel. With the aircraft size reduction (see 3A above) and the increase in basic weight, it is again suspect that previously unanticipated aeroelastic problems may be an area which should be explained in detail to Mr. Bissell or Mr. Kiefer.

C. Figure 3 of center of gravity vs gross weight has two unexplained errors: (1) the curve goes below the quoted zero fuel weight of 48,600 pounds and (2) the final portion of the curve shows an increase in aircraft gross weight as fuel is expended. Since tanks 5 and 6 are empty, there does not appear to be any way to move the c.g. forward for subsonic flight and landing below a weight of 52,500 pounds. The important aspects of this curve cannot be analyzed without the applicable stability and control curves.

D. Such curves as presented in Figure 5, page 18, are interesting but hardly to the point since straight line interpolation would not be a common technique. The prime airspeeds of the basic mission are 400 KEAS during the climb until Mach 3.2 is reached and cruise at Mach 3.2.. At altitudes from 85,000 to 95,000 feet at Mach 3.2,. the equivalent airspeed varies from 309 knots to 232 knots. The three basic airspeeds are 400,309, and 232 KEAS. The curves are for 400 and 200 KEAS.

E. It is possible to compare only two points of the curves of Figures 11 and 12. The sea level net thrusts of 63,800 and 64,000 pounds are quite close. However, at 4,500 feet altitude, there is a difference of 2,800 pounds of thrust. The sea level static net thrust of 50,000 pounds seems quite low. These figures could change in significant magnitudes, and Lockheed's problem of estimating the net thrust at this time is not unrecognized. The continuing AR studies and inlet modifications greatly influence the inlet recovery factor.

F. In the section on Airport Performance, the report makes the operational decision that smaller brakes and no drag chute will be the tactical configuration. This decision is not a Lockheed prerogative, but should be dictated by OXCART operations. My primary concern is the loss of an engine or the desire to abort for any reason at a speed of approximately 150 knots. Allowing 1,000 pounds of fuel used to obtain 150 knots, Figure 34 shows a ground roll distance of 43,000 feet. This eight mile ground roll far exceeds any possible level terrain capability. With a different stopping technique (Figure 35), it is possible to reduce this ground roll to 28,000 feet (4.5 miles) which is still an excessive distance.

G. The takeoff ground run chart (Figure 24) shows the runway required when operating at 115,000 pounds gross weight. The maximum temperature of 87°F to operate from an 8,000 foot runway will greatly restrict the training operations at the Area. Normal takeoff distance on a standard day, again allowing 1,000 pounds of fuel used to reach takeoff speed, requires 7,000 feet of runway. Slight miscalculations by the pilot, brake tapping, or minor thrust variations could make this a very marginal condition for a night takeoff combat mission.

H. Figure 21 gives the possible tail clearance presumedly at landing weights. However, the weight and balance chart does not show the possibility of being at landing weight and 19% c.g. at the same time. The chart also shows the angle of attack of the fuselage reference line to be approximately 9.7° and the wing angle of attack will be less due to the geometry of the aircraft. This is a relatively low angle when compared to present day delta wing aircraft and thus compromises full capability of the wing. The end result is, of course, higher touchdown speeds, longer ground rolls, and increased tire problems.

I. The climb and descent performance section is not understood by me. The equation used to find minimum fuel used in the climb involves, among other parameters, a kinetic energy correction factor and true speed of the airplane. The report states that the mathematical function containing these parameters is a constant. The appendix justifies using the kinetic energy correction factor as a constant which changes with altitude if the Mach number is held constant. This is not done in the climb until Mach 3.2 is reached. Upon reaching Mach 3.2, climb is continued at constant Mach at which time the true speed becomes a variable. Thus, the report has called two parameters as constants when, in reality, one remains

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constant at certain conditions of an erroneously presumed climb schedule and the other varies continuously.

J. In the "search and loiter" phase of the mission, Lockheed has again taken the operational initiative in allowing 1,800 pounds of fuel for search and join-up with the tanker and leaving only 900 pounds of fuel remaining at the time of "hook-up." This 1,800 pounds of fuel at optimum speed and 25,000 feet altitude, permits 9 minutes of search. If one engine is shut down, the time is increased 1.8 minutes to 10.8 minutes. The 900 pounds reserve is good for 4.5 minutes or approximately 36 miles. The curves given in Figures 71 and 72 for 19% c.g. are identical although one is for 80% of military thrust and the other is for 90% thrust.

K. The mission analyses section of the report is presented in a contradictory manner. The tabular summary and the mission breakdowns do not agree with the established ground rules of computation. In some instances the deviation from the ground rules makes the aircraft appear inferior in range to what should be shown. The figures given in the point to point range calculations are sometimes figures to be added and at other times the total of some or all of the previous figures. This confusion is tolerable. The equation given on page 105 is not used in the subsequent calculations. The radius loss figure of 68 nautical miles agrees with chart of Figure 87. However, Figure 87 supposedly an extension of Figures 85 and 86 is not consistent with those drawings. Figures 85 and 86 are consistent and show a range loss of 48 miles for a 180 degree turn at 1.2 g. The radius loss, then, should be 24 nautical miles rather than the 68 mile penalty accepted by Lockheed. The range of the aircraft is enhanced by the use of a centrifugal force factor. Use of this technique may be a questionable issue.

L. Although the climb angle and thrust vector corrections of Appendix B are stated to be small, I believe that there are some incorrect statements in the appropriate explanations. If the climb calculations were based on incorrect assumptions, the climb data will necessarily be in error. My basic difference here deals with magnitudes of affective parameters. The report states that in a climb, the lift is less than the weight of the airplane and therefore the drag due to lift is reduced. It further contends that the thrust vector inclination in the lift direction is the reason for this reduction in lift and drag. I take exception to both statements. True, the thrust vector inclination is a relieving force in the lift direction. However, starting from a given condition of cruise

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equilibrium, the wing reference line is rotated upward to initiate the climb. Due to the aircraft geometry, the thrust vector rotates the same amount. This thrust vector, however, is a function of the sine of the angle change and when calculated against the magnitude of lift change using Figure 9, page 22, the thrust factor is approximately a tenth that of the lift change. Thus, the thrust vector does reduce the wing lift required for a given climb rate and/or climb angle, but the over-all lift of the wing during the climb is greater than in cruise equilibrium. Since the lift is greater, the drag due to lift is also greater.

3. The complete method used to give greater range due to radical acceleration is not fully explained in Appendix C. However, the limited figures and curves presented, indirectly suggest a factor of 2%. Due to some of the example figures given, I question the technique and validity of the concept. The basic theory is to reduce the aircraft lift required to sustain flight due to the centrifugal force acting on the aircraft. This reduction in lift gives a direct reduction in drag. This gives a resultant decrease in thrust required, and thus less fuel required for any chosen time or range factor. However, the technique of application appears to be applied directly as a function of aircraft height above the ground while assuming the earth to be a perfect sphere. The earth, of course, is not such a perfect ball. Early reports show the radius in the North-South direction to be approximately 13.5 miles less than the equatorial radius. By coincidence, this closely approximates the A-12 altitude. By flying in the assumed standard atmosphere at a given pressure altitude, the airplane would stay at a constant tape-line height above the sea level datum. By flying in a northerly direction, the airplane would very closely approximate flying at a constant distance from the center of the earth and at a position over the geodetic pole be very close to the same distance from the earth's center as at ground conditions of takeoff. Perhaps all of such factors have been included in the data reduction, but such is not mentioned in the report and leads me to doubt that the range increase factor is as large as implied in the curve of Figure 84.

4. My over-all conclusion of the report is that it does not present consistent, usable data in such a manner as to provide this Headquarters the capability of operational preplanning. Certain "canned" mission profiles are shown but not with sufficient backup charts to select varying mission requirements and to interject pertinent

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operational considerations. Since the data is not consistent within the report, the entire methods and data presented are suspect.

5. I recommend that this report be reviewed by Lockheed for accuracy. Further, I recommend that the report be resubmitted in an operationally usable form such as the performance appendix of any pilots handbook type technical order. In such a presentation, the progress report would be enhanced by the capability of operational preplanning and alternate mission selection.

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SIGNED
[redacted]
MAJOR USAF

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